BALLY TAGA REPORT

DELIVERABLE DOCUMENT CONTROL SHEET

FINAL ANALYTICAL TAGA REPORT
CROSSLEY FARM SITE VAPOR INTRUSION STUDY
EPA Work Assignment No.: 0-220
Lockheed Martin
Work Order No.: EAC00220

SIGNATURES

Discipline	Reviewed	Date	Approved	Date
Task Leader [redacted]				
Analyst *Charles W. Shields*				
Peer *Danielle McCall*				
Peer *John Wood*				
Group Leader *Stephen L. Blaze*				
Analytical Section Leader				
Air Response Section Leader *Jeffrey Bradstreet*				
Support Section Leader				
Technical Section Leader				
Data Validation & Report Writing Group Leader				
Technical Editor				
QA/QC Coordinator				
QA Officer *Deborah H. Killeen*				
Project Manager [redacted]				

DATE: 28 February 2007

TO: David Mickunas, U.S. EPA/ERT Work Assignment Manager

THROUGH: [redacted]

FROM: [redacted]

SUBJECT: DOCUMENT TRANSMITTAL UNDER WORK ASSIGNMENT # 0-220

Attached please find the following document prepared under this work assignment:

FINAL ANALYTICAL TAGA REPORT
CROSSLEY FARM SITE VAPOR INTRUSION STUDY
HEREFORD TOWNSHIP, PA
FEBRUARY 2007

cc: Central File - WA # 0-220(w/attachment)
Electronic File – I:/Archive/REAC4/0-220/D/FA/28 February 2007
Dennis A. Miller, REAC Program Manager (w/o attachment)

FINAL ANALYTICAL TAGA REPORT
CROSSLEY FARM SITE VAPOR INTRUSION STUDY
HEREFORD TOWNSHIP, PA
FEBRUARY 2007

U.S. EPA Work Assignment No.: 0-220
LOCKHEED MARTIN Work Order No.: EAC00220
U.S. EPA Contract No.: EP-C-04-032

Submitted to
David Mickunas
U.S. EPA/ERT

Prepared by:
Lockheed Martin/REAC

[redacted]
REAC Task Leader

Date

Analysis and Preparation by:
Charles W. Shields

[redacted]
REAC Program Manager

Date

220-DFA-022807

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

The Environmental Protection Agency (EPA)/Environmental Response Team (ERT) issued Work Assignment (WA) Number 0-220, Crossley Farm Site Vapor Intrusion Study in Hereford Township, Pennsylvania (PA), to Lockheed Martin under the Response Engineering and Analytical Contract (REAC). As an element of this WA, REAC personnel were to conduct target compound monitoring using the ECA Trace Atmospheric Gas Analyzer (TAGA) IIe, to assist U.S. EPA Region III in its investigation of residential indoor air quality.

The TAGA air monitoring events conducted on 24 January 2007 were screening in nature. Air monitoring for trichloroethene and tetrachloroethene was performed in accordance with the REAC Draft Standard Operating Procedure (SOP) # 1711, *Trace Atmospheric Gas Analyzer (TAGA) IIe Operations*. Real-time monitoring for the target compounds was performed using a selected ion technique.

2.0 METHODOLOGY

2.1 Mass Spectrometer/Mass Spectrometer General Theory

The ECA TAGA IIe is based upon the Perkin-Elmer API 365 mass spectrometer/mass spectrometer (MS/MS) and is a direct air-monitoring instrument capable of detecting, in real time, trace levels of many organic compounds in ambient air. The technique of triple quadrupole MS/MS is used to differentiate and quantitate compounds.

The initial step in the MS/MS process involves simultaneous chemical ionization of the compounds present in a sample of ambient air. The ionization produces both positive and negative ions by donating or removing one or more electrons. The chemical ionization is a "soft" ionization technique, which allows ions to be formed with little or no structural fragmentation. These ions are called parent ions. The parent ions with different mass-to-charge (m/z) ratios are separated by the first quadrupole (the first MS of the MS/MS system). The quadrupole scans selected m/z ratios allowing only the parent ions with these ratios to pass through the quadrupole. Parent ions with m/z ratios different than those selected are discriminated electronically and fail to pass through the quadrupole.

The parent ions selected in the first quadrupole are accelerated through a collision cell containing uncharged nitrogen molecules in the second quadrupole. A portion of the parent ions entering the second quadrupole fragments as they collide with the nitrogen molecules. These fragment ions are called daughter ions. This process, in the second quadrupole, is called collision induced dissociation. The daughter ions are separated according to their m/z ratios by the third quadrupole (the second MS of the MS/MS system). The quadrupole scans selected m/z ratios, allowing only the daughter ions with these ratios to pass through the quadrupole. Daughter ions with m/z ratios different than those selected are discriminated electronically and fail to pass through the quadrupole. Daughter ions with the selected m/z ratios are then counted by an electron multiplier. The resulting signals are measured in ion counts per second (icps) for each parent/daughter ion pair selected. The intensity of the icps for each parent/daughter ion pair is directly proportional to the ambient air concentration of the organic compound that produced the ion pair. All of the ions discussed in this report have a single charge. The m/z ratios of all of the ions discussed are equal to the ion masses in atomic mass units (amu). Therefore, the terms parent and daughter masses are synonymous with parent and daughter ion m/z ratios.

2.2 TAGA Procedure

The TAGA was used to analyze indoor air and outdoor ambient air during mobile and stationary monitoring events. Indoor monitoring utilized a 300-foot corrugated Teflon® sampling hose. The

proximal end was attached to the TAGA source inlet, while the distal end was taken inside a unit during the indoor monitoring event. For mobile monitoring, one end of a 4-foot corrugated Teflon® sampling hose was connected to the TAGA source inlet, while the other was attached to a glass transfer tube passing through the top of the bus during the monitoring event. In both cases, air was continuously drawn through the hose at a set flow rate and transported to the TAGA source during the monitoring event.

2.2.1 TAGA Mass Calibration

At the beginning of the monitoring period, a gas mixture containing benzene, toluene, xylenes, tetrachloroethene, trichloroethene, trans-1,2-dichloroethene and vinyl chloride was introduced by a mass flow controller (MFC) into the sample air flow (SAF). The tuning parameters for the first quadrupole at 30, 78, 106, 130, and 166 amu, and the third quadrupole at 30, 78, 105, 129, and 166 amu were optimized for sensitivity and mass assignment. The peak widths were limited between 0.50 amu and 0.60 amu. The mass assignments were set to the correct values within 0.15 amu.

2.2.2 TAGA Response Factor Measurements

The TAGA was calibrated for the target compounds at the beginning and end of each day or before each survey. The calibration system consisted of a regulated gas cylinder containing a gas standard mixture of the target compounds connected to an in-line MFC. The MFC was calibrated with a National Institute of Standards and Technology (NIST) traceable flow rate meter. The gas standard certification is presented in Appendix A. The gas standard containing a known mixture of target compounds, certified by the supplier, was regulated at preset flow rates, and diluted with ambient air. The dilution of the gas standard resulted in known analyte concentrations. The calibration consisted of a zero point and five known concentrations obtained by setting the MFC to 0, 10, 20, 40, 80, and 90 milliliters per minute (mL/min) with the SAF at a constant flow rate of 1,500 milliliters per second (mL/sec).

The approximate concentration range of standards introduced into the TAGA was between 2 and 20 parts per billion by volume (ppbv). Utilizing the analytes' concentrations, gas flow rates, air sampling flow rates, and atmospheric pressure, response factors (RFs), in units of ion counts per second per part per billion by volume (icps/ppbv), were calculated for each calibration by using a least-square-fit algorithm to calculate the slope of its curve. The coefficient of variation was checked for each ion pair's RF to ensure that it was greater than 0.90. The RF of each analyte was used to quantify target compounds in ambient air, or the intermediate response factor (IRF) was calculated between pairs of calibrations and used to quantify target compounds in indoor air.

2.2.3 Transport Efficiency

The transport efficiency and residence time for the target compounds through the 300-foot length of corrugated Teflon® sampling hose was determined prior to and at the conclusion of indoor air monitoring activities each day. The transport efficiency was determined by introducing a known concentration of the target compounds into the proximal end and then into the distal end of the sampling hose. The signal intensity of each ion pair for each compound was measured in icps and the percent (%) transport efficiency calculated using the equation below:

$$\%\ transport\ \ efficiency\ =\ \frac{signal\ intensity\ at\ the\ distal\ end\ of\ the\ hose}{signal\ intensity\ at\ the\ proxiaml\ end\ of\ the\ hose}\ x\ 100$$

A transport efficiency of 85% is considered acceptable and results are summarized in Table 1.

The residence time is the interval, in seconds; it takes the air sample to travel the length of the sampling hose. The residence time, which reflects a time difference between the sampling and the instruments response, is incorporated in the offset. The offset, which is the total number of sequences acquired during the residence time, is applied to the monitoring files (Figures 1b to 4b and Figures 1c to 4c). Therefore, the observations and instrument responses are temporally coordinated.

2.2.4 TAGA Air Monitoring

TAGA monitoring was performed by continuously drawing air through the Teflon® hose at a flow-rate of approximately 1,500 mL/sec. The air was then passed through a glass splitter where the pressure gradient between the mass spectrometer core and the atmosphere causes a sample flow of approximately 10 mL/min into the ionization source through a heated transfer line. The flow into the TAGA source was controlled so that the ionization source pressure was maintained at an optimum value of approximately 2.4 torr. The remaining airflow was drawn through the air pump and vented from the TAGA bus.

Monitoring was performed in the parent/daughter ion-monitoring mode. As monitoring proceeded, the operator pressed letter keys (flags), alphabetically on a computer keyboard, to denote events or locations during the monitoring event. This information was also recorded on an event log sheet. The intensity of each parent/daughter ion pair monitored by the TAGA was recorded in a permanent file on the computer's hard drive. One set of recorded measurements of all the ion pairs is called a sequence.

At the beginning of each unit survey, a one-minute pre-entry ambient data segment was collected. At the operator's signal, the sampler then entered the unit while holding the distal end of the hose at breathing height. The sampler proceeded to each room in the unit where one-minute data segments were collected. After the rooms in the unit were monitored, a one-minute post-exit ambient data segment was collected. Upon completion of the one-minute post-exit ambient data segment, the instrumentation was challenged with the calibration standard, which was introduced at 30 mL/min (approximately 6 ppbv), to verify that the system was functioning properly.

2.3 Meteorological Monitoring

United States Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center provided the meteorological data for 24 January 2007. Data were collected at the Quakertown Automatic Weather Observing Station, Quakertown, PA, approximately 12 miles east of Hereford Township. Meteorological data, such as wind speed, wind direction, and rainfall, are summarized in Table 2 for the periods during which monitoring occurred. The compiled meteorological data are presented in Appendix B. The reported data for rainfall is an average of the data recorded during the hour preceding the time recorded in the table. The reported meteorological data for wind speed and direction represent a five-minute average collected prior to the time recorded in the table. Because of the distance of the meteorological monitoring location from the study location and the short averaging period, care should be exercised in relating meteorological conditions existing at the Crossley Farm Site Vapor Intrusion Study.

3.0 TAGA AIR MONITORING RESULTS

The TAGA was used to survey indoor air at an industrial facility in the vicinity of the Crossley Farm Site Vapor Intrusion Study. Mobile monitoring was also performed following a path around the facility.

3.1 Unit Surveys

Figures 1a through 4a, present the approximate floor plans of each unit. The monitoring locations are depicted in these figures. The monitoring locations marked by letters are the "flags" that the TAGA operator placed into the file. These "flags" mark events and are carried through the rest of the data presentation.

3.2 Mobile Monitoring Path

Figure 5a presents the monitoring path taken by the TAGA bus as it traveled around the Bally Site. The aerial map representing the monitoring path is marked by letters. These letters are the "flags" that the TAGA operator placed into the file. These "flags" mark events and are carried through the rest of the data presentation.

3.3 TAGA File Event Summaries

Figures 1b through 5b present the TAGA file event summaries. These are the observations made during the file acquisition by the TAGA operator, along with the times from the TAGA file and the letter "flags" used to mark the data, which are recorded by the TAGA computer.

3.4 Graphical Presentations

Figures 1c through 5c are the graphical representations of the TAGA files. A graph of each target compound concentration is presented with ppbv plotted on the vertical axis, and time into the acquisition, in minutes, on the horizontal axis. The target compound concentration was calculated by averaging the concentrations obtained from the ion pairs that were monitored for each target compound. The ion pairs used are provided in Section 5. There are two horizontal lines on each graph. The lower line is set at the detection limit (DL) for the compound. The higher line is set at the concentration equal to the quantitation limit (QL) for the target compound. When high concentrations are represented, the lower DL line may not be readily discerned. Transient, momentary spikes above the QL line are occasionally observed. These spikes, electronic in nature, do not affect average concentrations. They may be distinguished from elevated concentrations because the spikes are only present for one sequence and are often only present for one ion pair for the monitored compound.

3.5 TAGA Target Compound Summaries

Figures 1d through 4d present the TAGA target compound summaries. These figures contain the concentrations of the target compounds averaged over time, at the various locations logged into the TAGA file event summaries.

4.0 DISCUSSION OF RESULTS

The TAGA target compound summaries are represented in Figures 1d through 4d. During a survey, a one-minute average was measured in each room, or at various locations within a room. Only the highest average concentrations above the QL are listed below.

4.1 Unit Surveys

4.1.1 Bally Site Survey One, CFR022

Bally Site Survey One was performed on 24 January 2007 at 10:09:16 and is represented in Figures 1a through 1d. The average wind speed at the airport for the five-minute period ending at 09:40 was 7 miles per hour (mph) from 270 degrees. There was no precipitation during the preceding hour. The highest average concentration of trichloroethene was 55 ppbv adjacent to the women's bathroom between flags J and K. The highest average concentration of tetrachloroethene was 0.42 ppbv adjacent to the women's bathroom between flags J and K.

4.1.2 Bally Site Survey Two, CFR023

Bally Site Survey Two was performed on 24 January 2007 at 10:43:09 and is represented in Figures 2a through 2d. The average wind speed at the airport for the five-minute period ending at 10:40 was 8 mph from 290 degrees. There was no precipitation during the preceding hour. The highest average concentration of trichloroethene was 78 ppbv at hole in the floor 2 between flags T and U. The highest average concentration of tetrachloroethene was 0.85 ppbv at hole in the floor 2 between flags T and U.

4.1.3 Bally Site Survey Three, CFR024

Bally Site Survey Three was performed on 24 January 2007 at 11:55:21 and is represented in Figures 3a through 3d. The average wind speed at the airport for the five-minute period ending at 11:40 was 3 mph from 290 degrees. There was no precipitation during the preceding hour. The highest average concentration of trichloroethene was 32 ppbv at girder 3 between flags F and G. The highest average concentration of tetrachloroethene was 0.27 ppbv at girder 3 between flags F and G and at the door to Luciana property between flags D and E.

4.1.4 Bally Site Survey Four, CFR025

Bally Site Survey Four was performed on 24 January 2007 at 12:28:34 and is represented in Figures 4a through 4d. The average wind speed at the airport for the five-minute period ending at 12:40 was 5 mph from 300 degrees. There was no precipitation during the preceding hour. The highest average concentration of trichloroethene was 28 ppbv at the back wall between flags J and K. The highest average concentration of tetrachloroethene was 0.29 ppbv at the back wall between flags J and K.

4.2 Mobile Monitoring

During the mobile monitoring period, The TAGA bus monitored continuously while moving alongroads in the vicinity of the Crossley Farm Site Vapor Intrusion Study.

4.2.1 Bally Site Mobile Monitoring Survey, CFR029

Mobile monitoring was performed on 24 January 2007 at 14:35:32 and is represented in Figures 5a through 5c, starting at location A and ending at location M along the path depicted in Figure 5a. The average wind speed at the airport for the five-minute period ending at 14:40 was 6 mph from 310 degrees. There was no precipitation during the preceding hour. Trichloroethene and tetrachloroethene were not detected at or above their quantitation limits.

5.0 QUALITY ASSURANCE/QUALITY CONTROL

The compound parent/daughter ion pairs used are listed below.

Compound	Parent Ion Mass	Daughter Ion Mass
Trichloroethene	130	95
Trichloroethene	132	95
Trichloroethene	132	97
Tetrachloroethene	164	129
Tetrachloroethene	166	129
Tetrachloroethene	166	131

Tables 3 and 4, documents the RFs and IRFs generated during the calibration procedure for the individual ion pairs. Response Factors and Intermediate Response Factors were used to quantitate the ion pair concentrations.

The summaries of detection and quantitation limit data for the monitoring periods (Section 5.3) and Table 4) document the concentration, in ppbv, required for a compound's ion pair to be considered detectable and quantifiable during the specified monitoring period. The DL is defined as three times the standard deviation of the concentration for a compound's ion pair measured in an ambient air sample. The QL is defined as 10 times the standard deviation of the concentration for the same conditions.

The summaries of the target compound detection and quantitation limits measured during the monitoring periods (Section 5.4 and Tables 4 and 5) document the concentration, in ppbv, required for the compound to be considered detectable and quantifiable. The detection and quantitation limits for a compound result from averaging the appropriate detection and quantitation limits of the compound's ion pairs.

5.1 Intermediate Response Factor for Ion Pairs

Response factors were generated from the initial, and final calibration events, as described in the procedure (Section 2.2.2.). Table 3 contains the RFs in units of icps/ppbv. The initial and final RFs were used to calculate the IRFs, which were used to calculate the reported concentration results.

The following equation was used to calculate the IRFs found in Tables 3 and 4:

$$IRF = \frac{2\,(RF1 \times RF2)}{(RF1 + RF2)}$$

where:

IRF = Intermediate response factor (icps/ppbv)
RF_1 = The RF for an ion pair measured during the initial calibration event (icps/ppbv)
RF_2 = The RF for the same ion pair measured during the final calibration event (icps/ppbv)

For example, the entry for the 130/95 ion pair of trichloroethene from Table 3 for files CFR021 and CFR026,24 January 2007 is:

RF_1 = 1868.8 (icps/ppbv)
RF_2 = 1343.0 (icps/ppbv)

and then,

$$IRF = \frac{2(1868.8 \times 1343.0)}{(1868.8 + 1343.0)} = \frac{5{,}019{,}596.8}{3211.8} = 1562.9 \text{ icps/ppbv}$$

The result, 1562.9 icps/ppbv, is the intermediate response factor reported in Table 3 and used in Table 4.

5.2 Error Bars

The potential maximum concentration percent deviations for each target compound are presented in Table 3 and are called "error bars" for simplicity. They represent the potential bias in the concentration due to changes in the sensitivity of the TAGA. Error bars were calculated using the following equation:

$$\text{error bar} = \frac{|RF_1 - RF_2|}{(RF_1 + RF_2)} \times 100$$

where:

error bar = Maximum concentration percent deviation (unitless)
RF_1 = The RF for an ion pair measured during the initial calibration event (icps/ppbv)
RF_2 = The RF for the same ion pair measured during the final calibration event (icps/ppbv)

For example, the entry for the 130/95 ion pair of trichloroethene from Table 3 for files CFR021 and CFR026, 24 January 2007 is:

$RF_1 = 1868.8$
$RF_2 = 1343.0$

$$\text{error bar} = \frac{|1868.8 - 1343.0|}{(1868.8 + 1343.0)} \times 100 = 16.4\%$$

The % error bar calculated for the 130/95 ion pair of trichloroethene is 16.4 % for files CFR021 and CFR026.

The above calculation was repeated for each ion pair. The error bars for each of the compound's ions were averaged to give a single value for the compound. This averaged error bar can be applied to the samples analyzed between the two calibrations of the sampling period.

5.3 Ion Pair Detection and Quantitation Limits

The DLs and QLs were calculated using the standard deviation (SD) of the compound's ion pair intensity measured in an ambient air sample and its RF. The SD reflects the variability of the instrument's response to the ambient air sample.

The following equation was used to calculate the DLs found in Tables 4 and 5:

$$DL = \frac{3 \times SD}{RF \text{ or } IRF}$$

where:

DL = Detection limit for an ion pair (ppbv)
SD = Standard deviation of the ion intensity measured in an ambient air sample (icps)
RF/IRF = Response factor/ Intermediate response factor for an ion pair (icps/ppbv)

For example, the entry for the 130/95 ion pair of trichloroethene from Table 4, files CFR021 and CFR026, 24 January 2007 is:

SD = 17.939 icps
IRF = 1562.9 icps/ppbv

$$DL = \frac{3 \times 17.939}{1562.9} = 0.03443 \text{ ppbv}$$

The following equation was used to calculate the quantitation limits found in Tables 4 and 5:

$$QL = \frac{10 \times SD}{RF \text{ or } IRF}$$

where:

QL = Quantitation limit concentration for an ion pair (ppbv)
SD = Standard deviation of the ion intensity measured in an ambient air sample (icps)
RF/IRF = Response factor/ Intermediate response factor for an ion pair (icps/ppbv)

For example, the entry for the 130/95 ion pair of trichloroethene from Table 3, files CFR021 and CFR026, 24 January 2007 is

SD = 17.939 icps
IRF = 1562.9 icps/ppbv

$$QL = \frac{10 \times 17.939}{1562.9} = 0.1148 \text{ ppbv}$$

5.4 Compound Detection and Quantitation Limits

Averaging the respective DLs and QLs of the target compound's ion pairs found in Table 4 generated the DLs and QLs found in Tables 4 and 5.

The following equation was used to calculate the compound's DL:

$$DL_c = \frac{DL_1 + DL_2 + \ldots + DL_n}{n}$$

where:

DL_c = Detection limit for a compound (ppbv)
DL_1 = Detection limit for the first ion pair (ppbv)
DL_2 = Detection limit for the second ion pair (ppbv)
DL_n = Detection limit for the n^{th} ion pair (ppbv)
n = Number of ion pairs to be averaged

For example, using the entries for the 130/95, 132/95, and 132/97 ion pairs of trichloroethene from Table 4 for files CFR021 and CFR026, 24 January, 2007 is:

$$DL_c = \frac{0.0344 + 0.0434 + 0.0344}{3} = \frac{0.1122}{3} = 0.0374 \text{ ppbv}$$

This result, 0.0374 ppbv, rounded to 0.037 ppbv is the DL for trichloroethene found in the Bally Site Survey One, 24 January 2007 entry of Table 5.

The following equation was used to calculate the compound's QL:

$$QL_c = \frac{QL_1 + QL_2 + \ldots QL_n}{n}$$

where:

QL_c = Quantitation limit for a compound (ppbv)
QL_1 = Quantitation limit for the first ion pair (ppbv)
QL_2 = Quantitation limit for the second ion pair (ppbv)
QL_n = Quantitation limit for the n^{th} ion pair (ppbv)
n = Number of ion pairs to be averaged

For example, using the entries for the 130/95, 132/95, and 132/97 ion pairs of trichloroethene from Table 4 for files CFR021 and CFR026, 24 January 2007 is:

$$QL_c = \frac{0.115 + 0.145 + 0.115}{3} = \frac{0.375}{3} = 0.125 \text{ ppbv}$$

This result, 0.125 ppbv rounded to 0.12 ppbv is the QL for trichloroethene found in the Bally Site Survey One, 24 January 2007 entry of Table 5.

TABLES

TABLE 1
Summary of Transport Efficiencies Measured on 24 January 2007
Crossley Farm Site Vapor Intrusion Study
Hereford Township, PA
February 2007

Transport Efficiency for 24 January 2007 06:27:25 File: CRF019				
Start Sequence:		337	717	
End Sequence:		427	818	
Compound	PM/DM	Proximal Intensity (icps)	Distal Intensity (icps)	Transport Efficiency (%)
Trichloroethene	130/95	49400.1	47457.4	96 %
Trichloroethene	132/95	14547.4	14256.9	98%
Trichloroethene	132/97	31507.8	30259.8	96%
Average Trichloroethene Transport Efficiency:				96%
Tetrachloroethene	164/129	23940.9	22752.4	95%
Tetrachloroethene	166/129	6910.3	6743.2	97%
Tetrachloroethene	166/131	20637.1	19623.5	95%
Average Tetrachloroethene Transport Efficiency:				95%

Transport Efficiency for 24 January 2007 13:51:47 File: CRF027				
Start Sequence:		201	483	
End Sequence:		298	579	
Compound	PM/DM	Proximal Intensity (icps)	Distal Intensity (icps)	Transport Efficiency (%)
Trichloroethene	130/95	27903.9	27356.6	98%
Trichloroethene	132/95	8154.9	8147.0	99%
Trichloroethene	132/97	17583.0	17247.0	98%
Average Trichloroethene Transport Efficiency:				98%
Tetrachloroethene	164/129	15060.7	14509.0	96%
Tetrachloroethene	166/129	4266.8	4185.8	98%
Tetrachloroethene	166/131	13097.0	12606.9	96%
Average Tetrachloroethene Transport Efficiency:				96%

PM/DM = parent mass/daughter mass
icps = ion counts per second
% = percent

TABLE 2
Summary of Meteorological Conditions During Monitoring on 24 January 2007
Crossley Farm Site Vapor Intrusion Study
Hereford Township, Pennsylvania
February 2007

File	Location	Date	Start Time	Wind Speed (mph)	Wind Direction (degrees)	Rainfall (inches)
CFR022	Survey one	01/24/07	10:09:16	7	270	-
CFR023	Survey two	01/24/07	10:43:09	8	290	-
CFR024	Survey three	01/24/07	11:55:21	3	290	-
CFR025	Survey four	01/24/07	12:28:34	5	300	-
CFR029	Mobile Survey	01/24/07	14:35:32	6	310	-

The wind direction is the direction from which the wind is blowing
mph = miles per hour
- = no precipitation

TABLE 3
Response Factors and Error Bars for 24 January 2007
Crossley Farm Site Vapor Intrusion Study
Hereford Township, Pa
February 2007

Calibration Files: CFR021 and CFR026 on 24 January 2007 Used for Unit Survey Files: CFR022, CFR023, CFR024, and CFR025					
Compound	PM/DM	Initial Response Factor	Final Response Factor	Intermediate Response Factor	Error Bar (%)
Trichloroethene	130/95	1868.8	1343.0	1562.9	16.4
Trichloroethene	132/95	562.94	404.38	470.66	16.4
Trichloroethene	132/97	1170.0	854.03	987.33	15.6
				Average:	16
Tetrachloroethene	164/129	1014.7	746.58	860.23	15.2
Tetrachloroethene	166/129	307.15	216.73	254.14	17.3
Tetrachloroethene	166/131	882.47	642.17	743.38	15.8
				Average:	16

Response factors are in units of icps/ppbv
PM/DM = parent mass/daughter mass
% = percent
icps = ion counts per second
ppbv = parts per billion by volume

TABLE 4
Summary of Detection and Quantitation Limit Data for 24 January 2007
Crossley Farm Site Vapor Intrusion Study
Hereford Township, PA
February 2007

Calibration Files: CFR021 and CFR026 on 24 January 2007 Used for Survey Files: CFR022, CFR023, CFR024, and CFR025					
Compound	PM/DM	Intermediate Response Factor (icps/ppbv)	Standard Deviation (icps)	Detection Limit (ppbv)	Quantitation Limit (ppbv)
Trichloroethene	130/95	1562.9	17.939	0.0344	0.115
Trichloroethene	132/95	470.66	6.8171	0.0434	0.145
Trichloroethene	132/97	987.33	11.315	0.0344	0.115
			Average:	0.037	0.12
Tetrachloroethene	164/129	860.23	13.519	0.0473	0.157
Tetrachloroethene	166/129	254.14	4.5466	0.0537	0.179
Tetrachloroethene	166/131	743.38	12.855	0.0519	0.174
			Average:	0.051	0.17
Calibration File: CFR028 at 14:11:23 on 24 January 2007 Used for Survey File: CFR029					
Compound	PM/DM	Response Factor (icps/ppbv)	Standard Deviation (icps)	Detection Limit (ppbv)	Quantitation Limit (ppbv)
Trichloroethene	130/95	1487.9	21.710	0.0438	0.146
Trichloroethene	132/95	446.75	6.9079	0.0464	0.155
Trichloroethene	132/97	938.29	10.748	0.0344	0.116
			Average:	0.042	0.14
Tetrachloroethene	164/129	789.94	10.399	0.0395	0.132
Tetrachloroethene	166/129	229.12	4.5692	0.0598	0.199
Tetrachloroethene	166/131	681.08	9.8403	0.0433	0.145
			Average:	0.048	0.16

PM/DM = parent mass/daughter mass
icps = ion counts per second
ppbv = part per billion by volume

TABLE 5
Unit Survey Detection and Quantitation Limits
Crossley Farm Site Vapor Intrusion Study
Hereford Township, Pennsylvania
February 2007

Unit Number Calibration Files	Bally Site Survey One CFR021 and CFR026		Bally Site Survey Two CFR021 and CFR026		Bally Site Survey Three CFR021 and CFR026	
Compound	Detection Limit	Quantitation limit	Detection Limit	Quantitation limit	Detection Limit	Quantitation limit
Trichloroethene	0.037	0.12	0.037	0.12	0.037	0.12
Tetrachloroethene	0.051	0.17	0.051	0.17	0.051	0.17
Unit Number Calibration Files	Bally Site Survey Four CFR021 and CFR026		Bally Site Mobile Monitoring Survey CFR028			
Compound	Detection Limit	Quantitation limit	Detection Limit	Quantitation limit		
Trichloroethene	0.037	0.12	0.042	0.14		
Tetrachloroethene	0.051	0.17	0.048	0.16		

All Detection and Quantitation limits are in parts per billion by volume

FIGURES

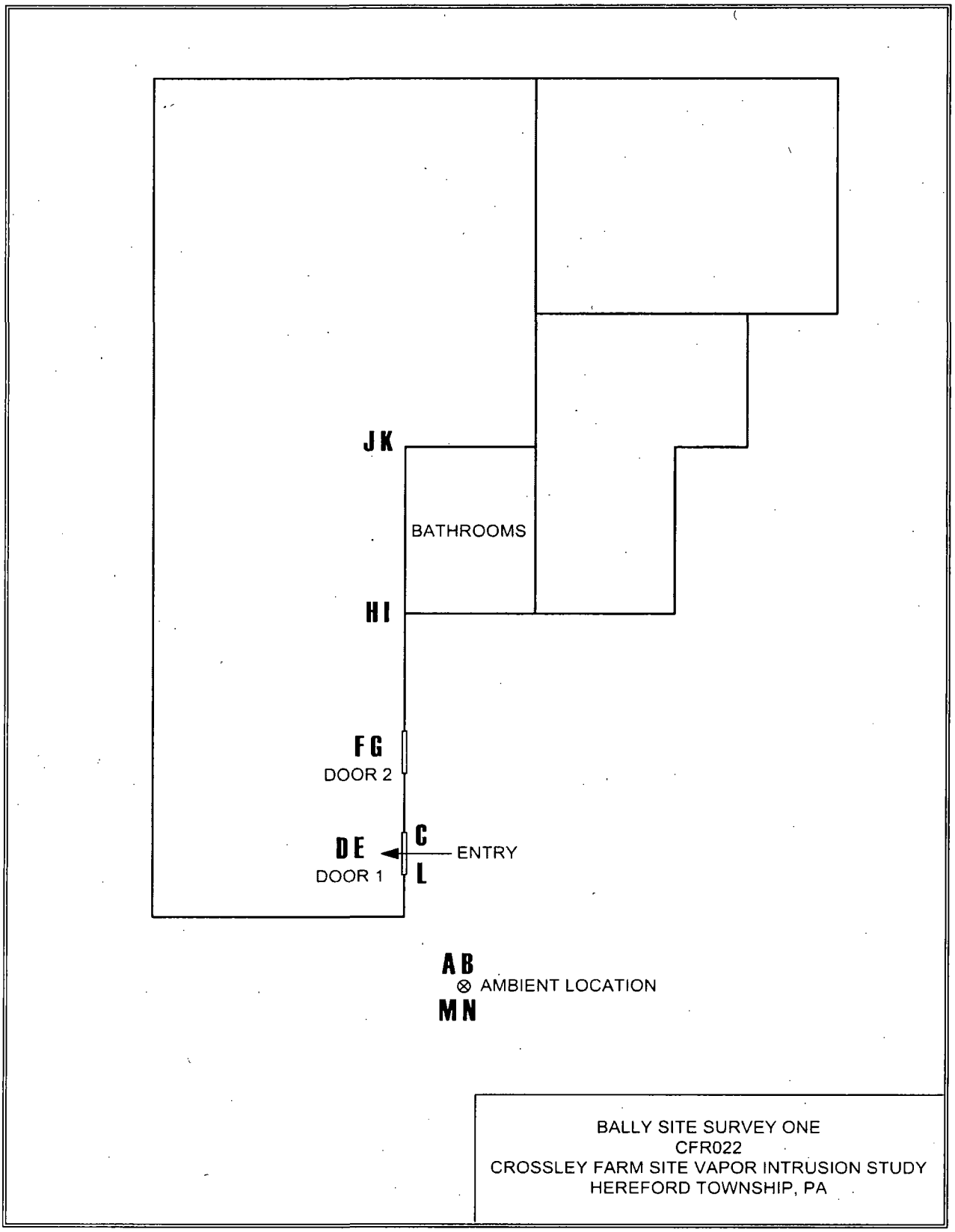
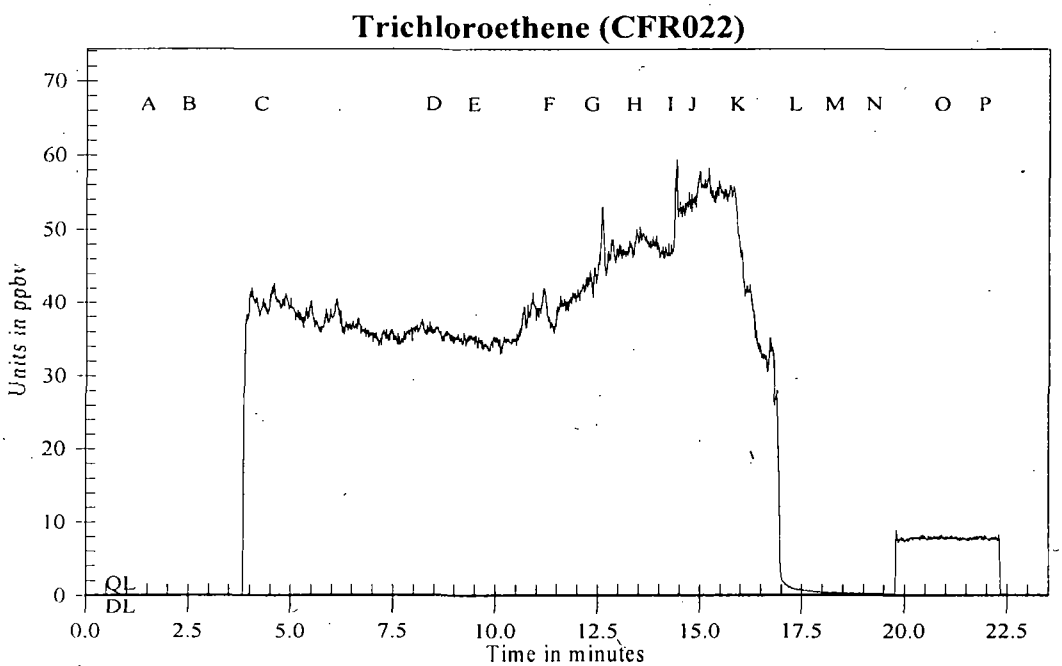


Figure 1a Bally Site Survey One Floor Plan, CFR022

Figure 1b

TAGA File Event Summary
File: CFR022 Acquired on 24 January 2007 at 10:09:16
Title: Bally Site Survey One

Flag	Offset Time	Offset Sequence	Description
A	1.3	123	Start of the pre-entry ambient
B	2.3	219	End of the pre-entry ambient
C	4.1	387	Entering the unit
D	8.3	784	Start of door 1
E	9.3	881	End of door 1
F	11.1	1056	Start of door 2
G	12.1	1151	End of door 2
H	13.2	1249	Start opposite of the men's bathroom
I	14.2	1344	End opposite of the men's bathroom
J	14.7	1393	Start adjacent to the women's bathroom
K	15.7	1490	End adjacent to the women's bathroom
L	17.1	1626	Exiting the unit
M	18.0	1711	Start of the post-exit ambient
N	19.0	1806	End of the post-exit ambient
O	20.7	1964	Start of the 30 mL/min spike
P	21.8	2066	End of the 30 mL/min spike



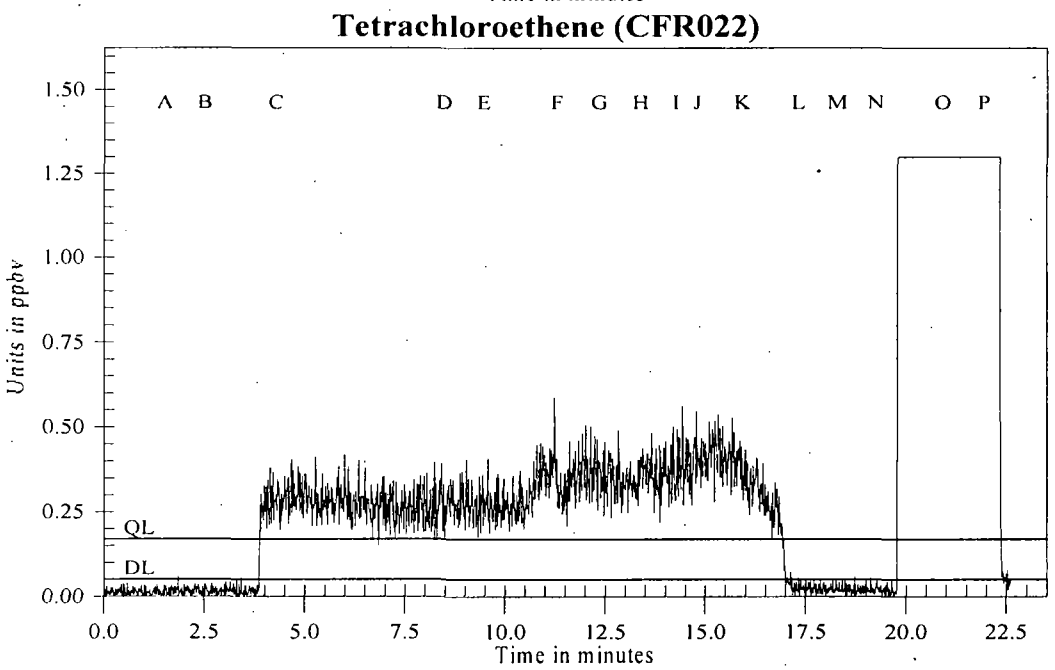


Figure 1c Bally Site Survey One for Trichloroethene and Tetrachloroethene

Figure 1d

TAGA Target Compound Survey Summary for Bally Site Survey One File: CFR022 Acquired on 24 January 2007 at 10:09:16			
		Trichloroethene	Tetrachloroethene
	Detection Limits (DL):	0.037	0.051
	Quantitation Limits (QL):	0.12	0.17
Flags	Description	Trichloroethene	Tetrachloroethene
A - B	Pre-entry ambient	DL=0.037	DL=0.051
D - E	Door 1	36.	0.28
F - G	Door 2	40.	0.35
H - I	Opposite Men's bathroom	48.	0.36
J - K	Adjacent Women's bathroom	55.	0.42
M - N	Post-exit ambient	0.34	DL=0.051
O - P	30 mL/min spike	7.8	7.2

Concentrations are in parts per billion by volume (ppbv)
J = Below quantitative limits

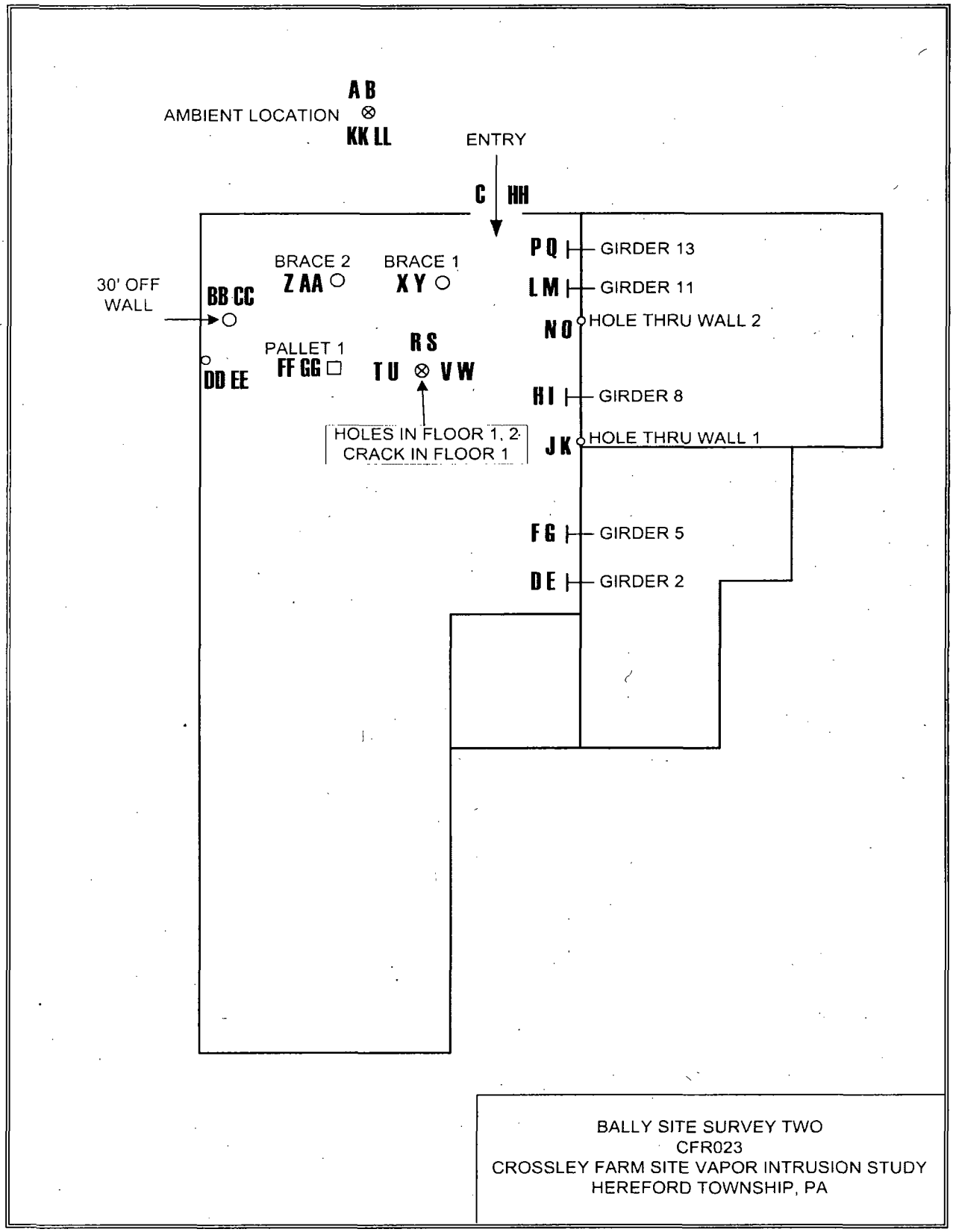


Figure 2a Bally Site Survey Two Floor Plan, CFR023

Figure 2b

TAGA File Event Summary
File: CFR023 Acquired on 24 January 2007 at 10:43:09
Title: Bally Site Survey Two

Flag	Offset Time	Offset Sequence	Description
A	1.5	142	Start of the pre-entry ambient
B	2.6	246	End of the pre-entry ambient
C	3.9	373	Entering the unit
D	7.9	749	Start of girder 2
E	8.9	844	End of girder 2
F	9.6	908	Start of girder 5
G	10.6	1006	End of girder 5
H	11.3	1074	Start of girder 8
I	12.3	1167	End of girder 8
J	12.8	1213	Start of the hole through the wall 1
K	13.8	1308	End of the hole through the wall 1
L	14.5	1373	Start of girder 11
M	15.5	1468	End of girder 11
N	15.8	1504	Start of the hole through the wall 2
O	17.0	1612	End of the hole through the wall 2
P	17.9	1699	Start of girder 13
Q	18.9	1793	End of girder 13
R	19.3	1833	Start of the hole in the floor 1
S	20.3	1928	End of the hole in the floor 1
T	20.7	1963	Start of the hole in the floor 2
U	21.7	2061	End of the hole in the floor 2
V	22.2	2110	Start of the crack in the floor 1
W	23.2	2205	End of the crack in the floor 1
X	23.7	2252	Start of brace 1
Y	24.8	2350	End of brace 1
Z	25.1	2387	Start of brace 2
AA	26.1	2482	End of brace 2
BB	27.3	2588	Start 30 feet off the wall
CC	28.4	2695	End 30 feet off the wall
DD	29.0	2757	Start of wall
EE	30.0	2852	End of wall
FF	31.1	2950	Start of pallet 1
GG	32.1	3046	End of pallet 1
HH	36.9	3507	Exiting the unit
KK	40.6	3855	Start of the post-exit ambient
LL	41.6	3950	End of the post-exit ambient
MM	43.6	4141	Start of the 30 mL/min spike
NN	44.6	4234	End of the 30 mL/min spike

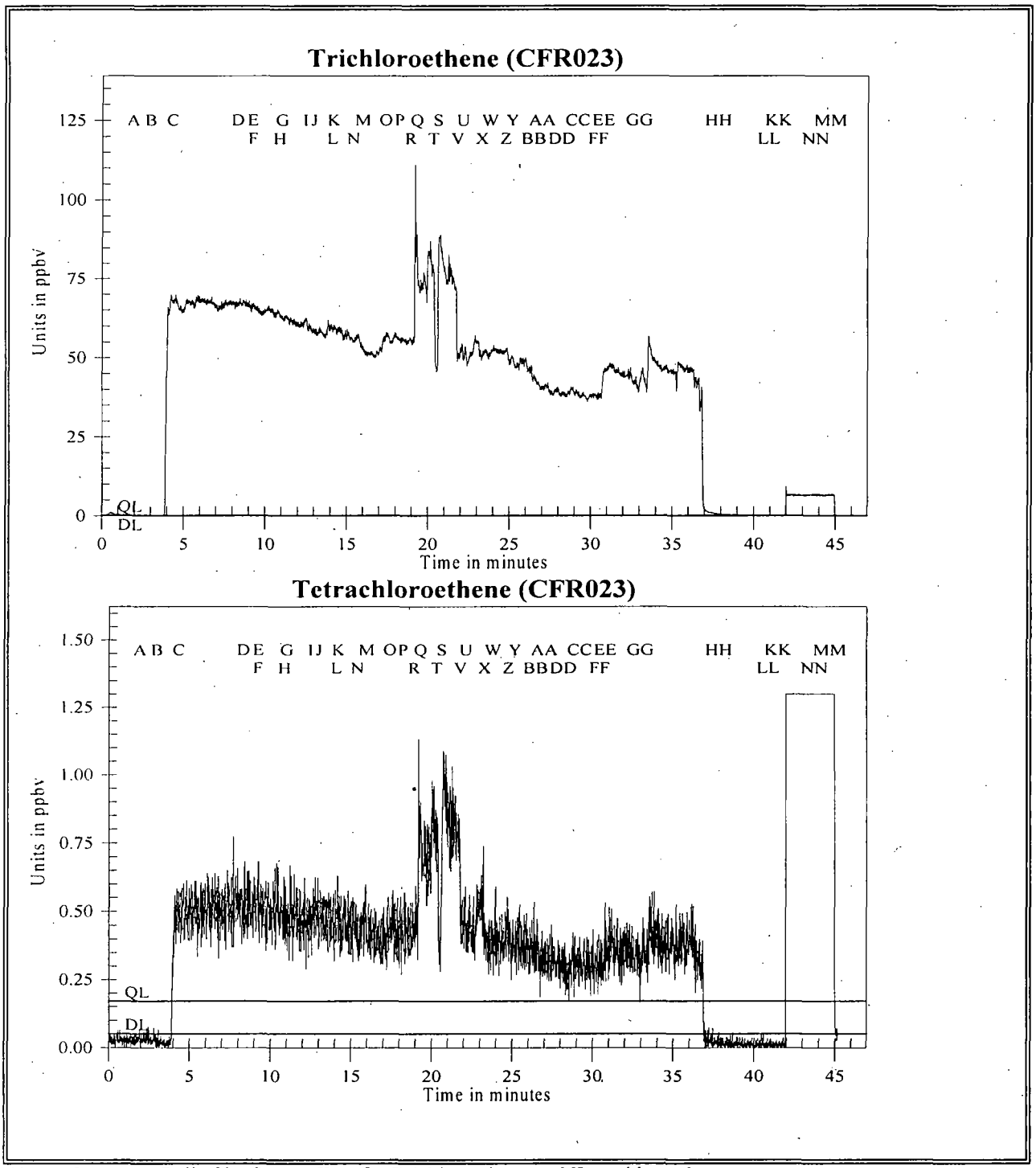


Figure 2c Bally Site Survey Two for Trichloroethene and Tetrachloroethene

Figure 2d

TAGA Target Compound Survey Summary for Bally Site Survey Two File: CFR023 Acquired on 24 January 2007 at 10:43:09			
		Trichloroethene	Tetrachloroethene
	Detection Limits (DL):	0.037	0.051
	Quantitation Limits (QL):	0.12	0.17
Flags	Description	Trichloroethene	Tetrachloroethene
A - B	Pre-entry ambient	0.30	DL=0.051
D - E	Girder 2	67.	0.52
F - G	Girder 5	65.	0.50
H - I	Girder 8	61.	0.48
J - K	Hole through the wall 1	58.	0.48
L - M	Girder 11	57.	0.45
N - O	Hole through the wall 2	52.	0.41
P - Q	Girder 13	56.	0.43
R - S	Hole in the floor 1	76.	0.74
T - U	Hole in the floor 2	78.	0.85
V - W	Crack in the floor 1	52.	0.47
X - Y	Brace 1	52.	0.40
Z - AA	Brace 2	48.	0.38
BB - CC	30 feet off the wall	39.	0.31
DD - EE	Wall	38.	0.30
FF - GG	Pallet 1	46.	0.37
KK - LL	Post-exit ambient	0.21	DL=0.051
MM - NN	30 mL/min spike	6.6	6.0

Concentrations are in parts per billion by volume (ppbv)
J = Below quantitative limits

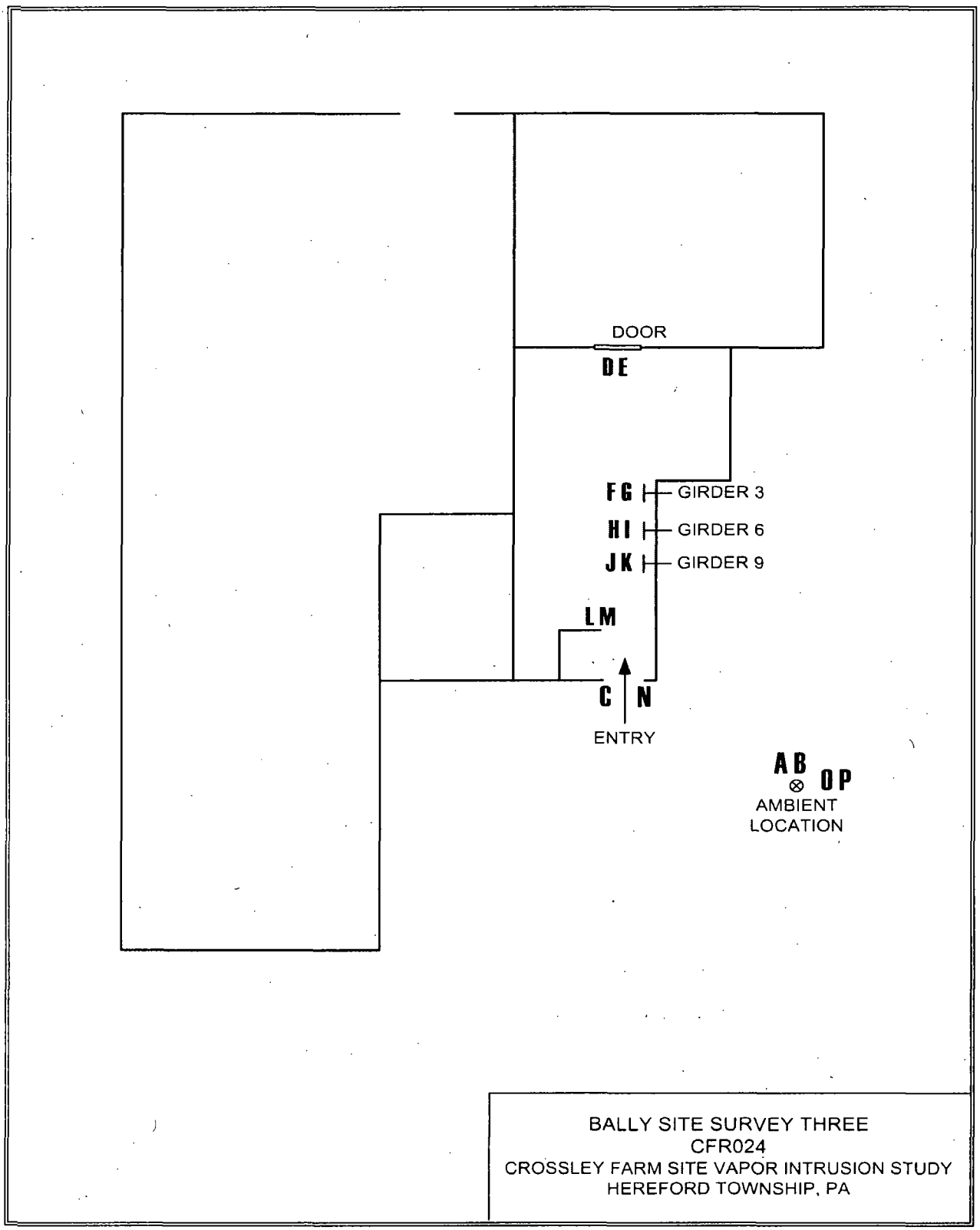
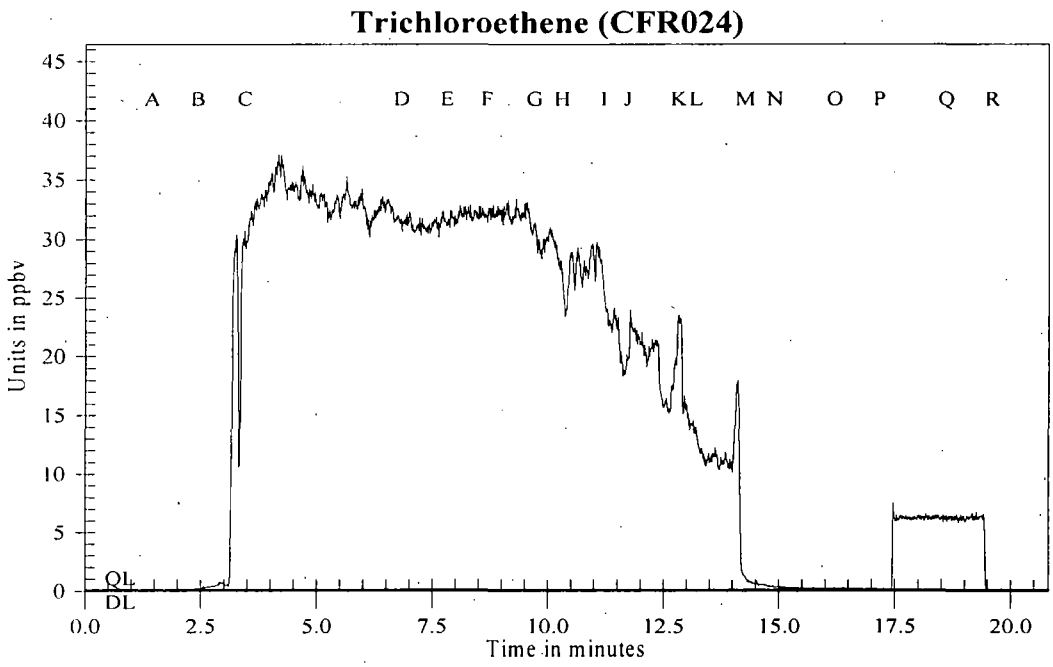


Figure 3a Bally Site Survey Three Floor Plan, CFR024

Figure 3b

TAGA File Event Summary File: CFR024 Acquired on 24 January 2007 at 11:55:21 Title: Bally Site Survey Three			
Flag	Offset Time	Offset Sequence	Description
A	1.3	120	Start of the pre-entry ambient
B	2.3	215	End of the pre-entry ambient
C	3.3	311	Entering the unit
D	6.6	631	Start of door towards Luciana property
E	7.7	727	End of door towards Luciana property
F	8.5	810	Start of girder 3
G	9.5	904	End of girder 3
H	10.1	961	Start of girder 6
I	11.1	1056	End of girder 6
J	11.6	1104	Start of girder 9
K	12.6	1200	End of girder 9
L	13.0	1238	Start at the entry to the door way
M	14.0	1333	End at the entry to the door way
N	14.7	1398	Exiting the unit
O	16.0	1520	Start of the post-exit ambient
P	17.0	1615	End of the post-exit ambient
Q	18.4	1749	Start of the 30 mL/min spike
R	19.4	1844	End of the 30 mL/min spike



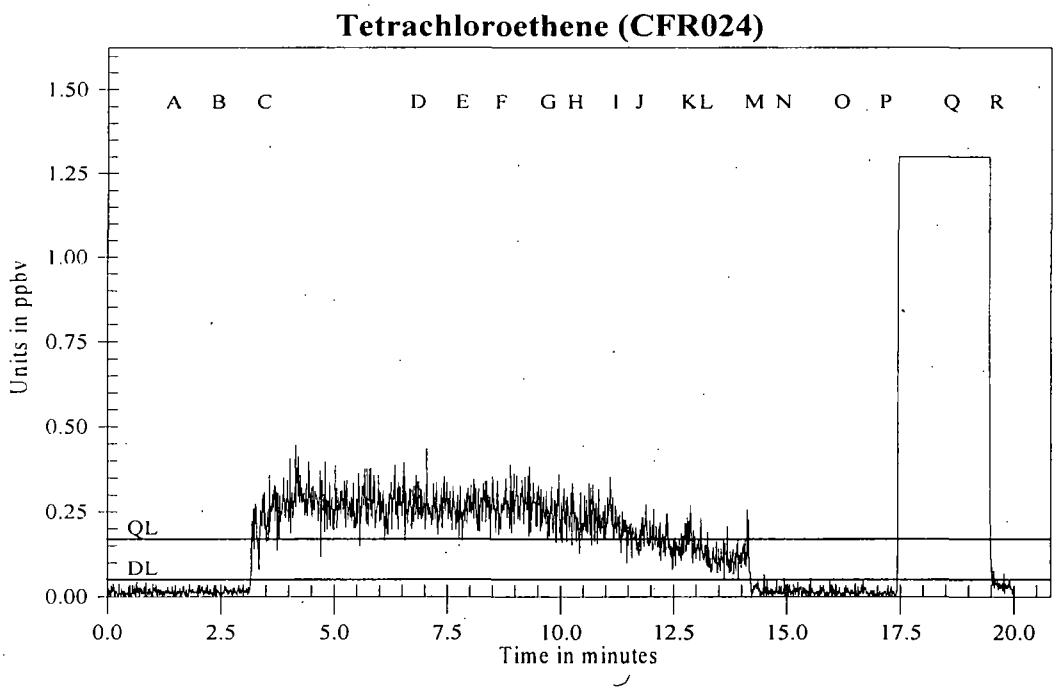


Figure 3c Bally Site Survey Three for Trichloroethene and Tetrachloroethene

Figure 3d

TAGA Target Compound Survey Summary for Bally Site Survey Three File: CFR024 Acquired on 24 January 2007 at 11:55:21			
		Trichloroethene	Tetrachloroethene
	Detection Limits (DL):	0.037	0.051
	Quantitation Limits (QL):	0.12	0.17
Flags	Description	Trichloroethene	Tetrachloroethene
A - B	Pre-entry ambient	0.088J	DL=0.051
D - E	Door to Luciana property	31.	0.27
F - G	Girder 3	32.	0.27
H - I	Girder 6	28.	0.23
J - K	Girder 9	20.	0.17
L - M	Entry to the door way	12.	0.12J
O - P	Post-exit ambient	0.22	DL=0.051
Q - R	30 mL/min spike	6.3	5.7

Concentrations are in parts per billion by volume (ppbv)
J = Below quantitative limits

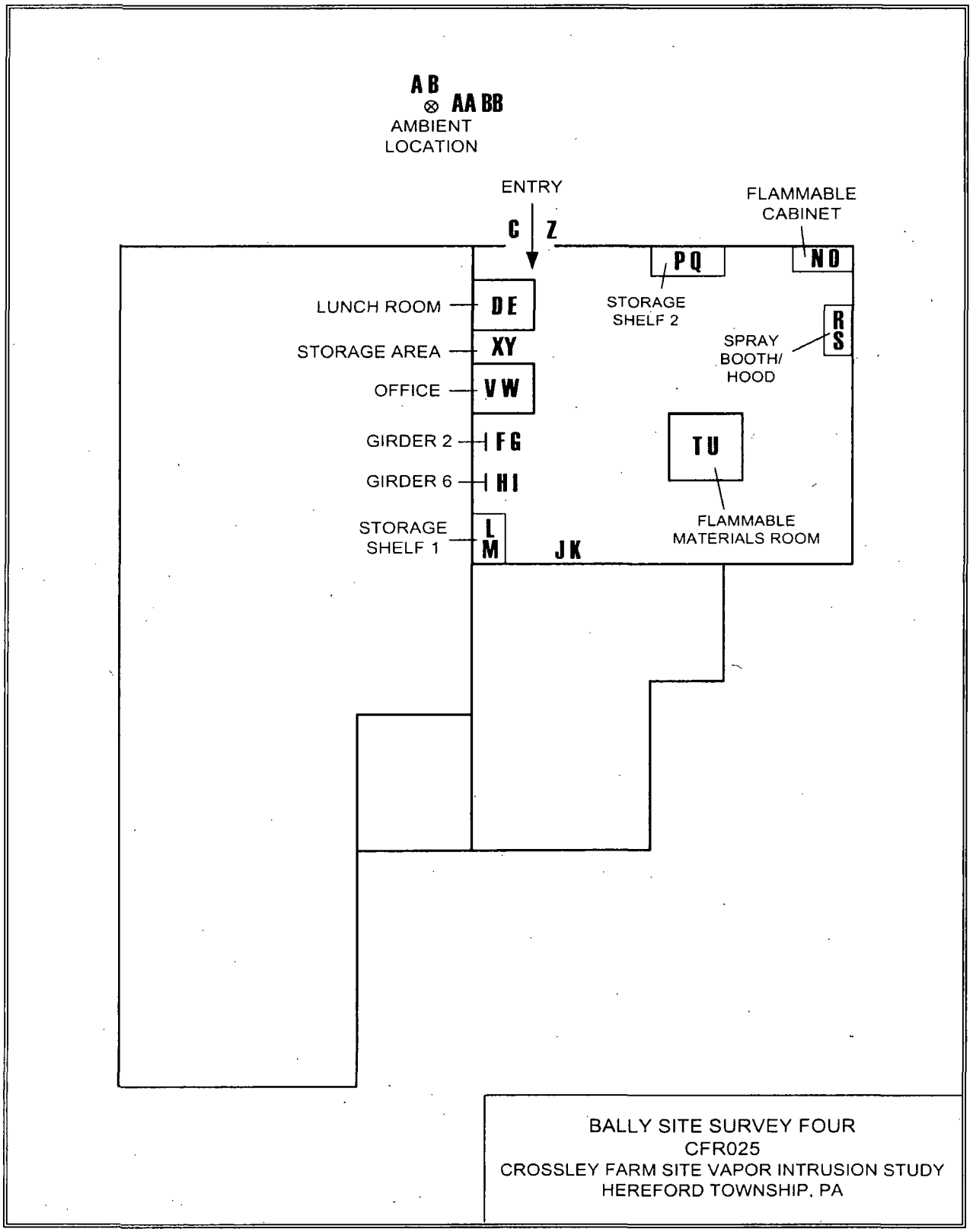


Figure 4a Bally Site Survey Four Floor Plan, CFR025

Figure 4b

TAGA File Event Summary
File: CFR025 Acquired on 24 January 2007 at 12:28:34
Title: Bally Site Survey Four

Flag	Offset Time	Offset Sequence	Description
A	1.4	136	Start of the pre-entry ambient
B	2.4	231	End of the pre-entry ambient
C	2.9	280	Entering the unit
D	5.0	477	Start of lunch room
E	6.0	572	End of lunch room
F	7.3	692	Start of girder 2
G	8.3	787	End of girder 2
H	9.2	870	Start of girder 6
I	10.2	965	End of girder 6
J	10.7	1015	Start at the back wall
K	11.7	1112	End at the back wall
L	13.2	1251	Start of storage shelf 1(chemicals)
M	14.2	1346	End of storage shelf 1 (chemicals)
N	16.4	1556	Start of flammable cabinet
O	17.4	1651	End of flammable cabinet
P	17.8	1686	Start of storage shelf 2 (chemicals)
Q	18.8	1782	End of storage shelf 2 (chemicals)
R	20.2	1914	Start of spray booth/hood
S	21.2	2010	End of spray booth/hood
T	23.3	2208	Start of flammable materials room
U	24.3	2303	End of flammable materials room
V	26.5	2516	Start of the office
W	27.5	2611	End of the office
X	28.0	2656	Start of the storage area (above the office)
Y	29.0	2749	End of the storage area (above the office)
Z	32.0	3040	Exiting the unit
AA	34.3	3258	Start of the post-exit ambient
BB	35.3	3353	End of the post-exit ambient
CC	36.6	3475	Start of the 30 mL/min spike
DD	37.6	3572	End of the 30 mL/min spike

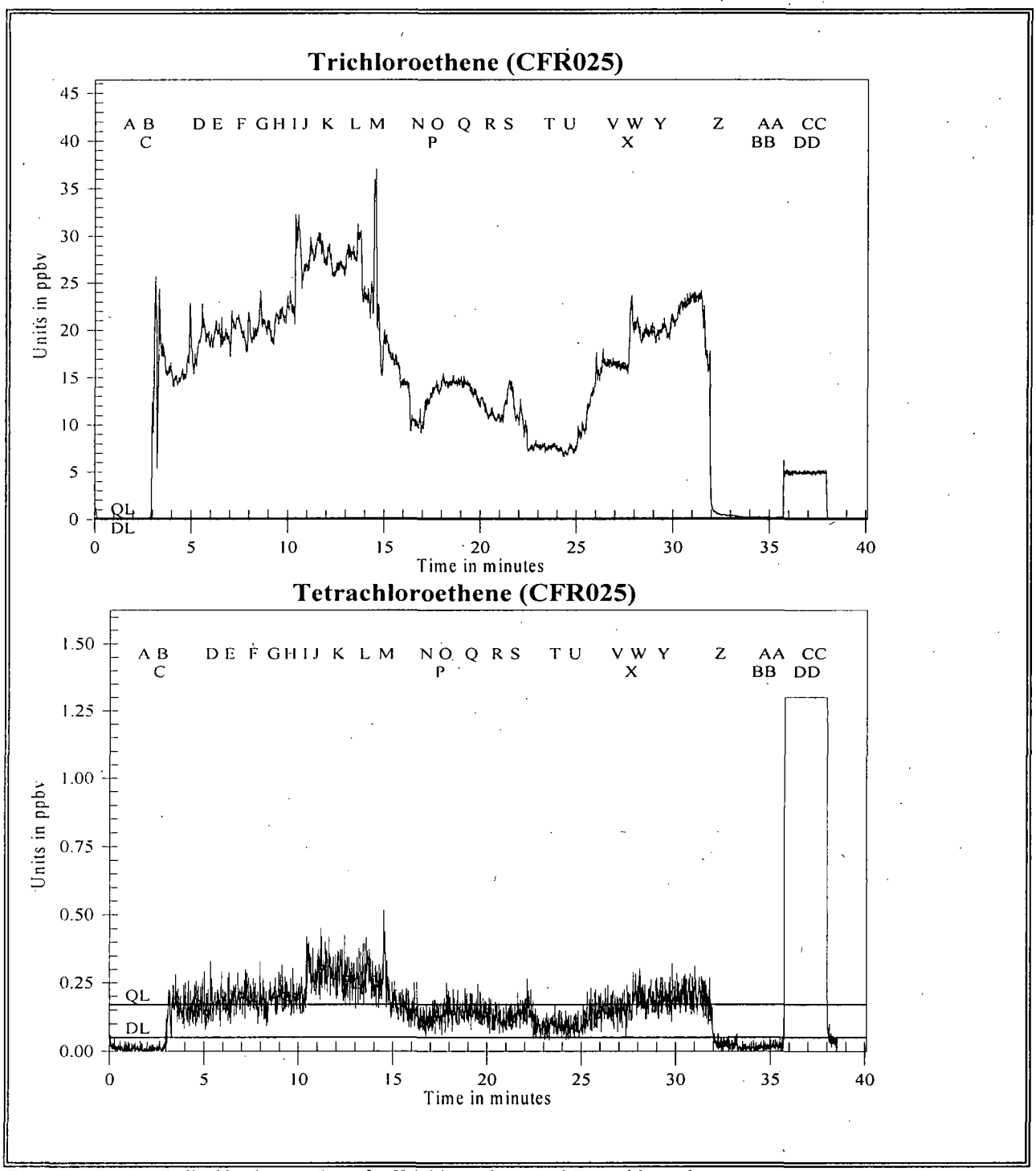


Figure 4c Bally Site Survey Four for Trichloroethene and Tetrachloroethene

Figure 4d

TAGA Target Compound Survey Summary for Bally Site Survey Four File: CFR025 Acquired on 24 January 2007 at 12:28:34			
		Trichloroethene	Tetrachloroethene
	Detection Limits (DL):	0.037	0.051
	Quantitation Limits (QL):	0.12	0.17
Flags	Description	Trichloroethene	Tetrachloroethene
A - B	Pre-entry ambient	0.072J	DL=0.051
D - E	Lunchroom	19.	0.17
F - G	Girder 2	20.	0.18
H - I	Girder 6	21.	0.20
J - K	Back wall	28.	0.29
L - M	Storage shelf 1 (chemicals)	27.	0.27
N - O	Flammable cabinet	11.	0.12J
P - Q	Storage shelf 2 (chemicals)	14.	0.15J
R - S	Spray Booth/Hood	11.	0.12J
T - U	Flammable materials room	7.6	0.097J
V - W	Office	16.	0.16J
X - Y	Storage area	20.	0.19
AA - BB	Post-exit ambient	0.20	DL=0.051
CC - DD	30 mL/min spike	5.0	4.9

Concentrations are in parts per billion by volume (ppbv)
J = Below quantitative limits

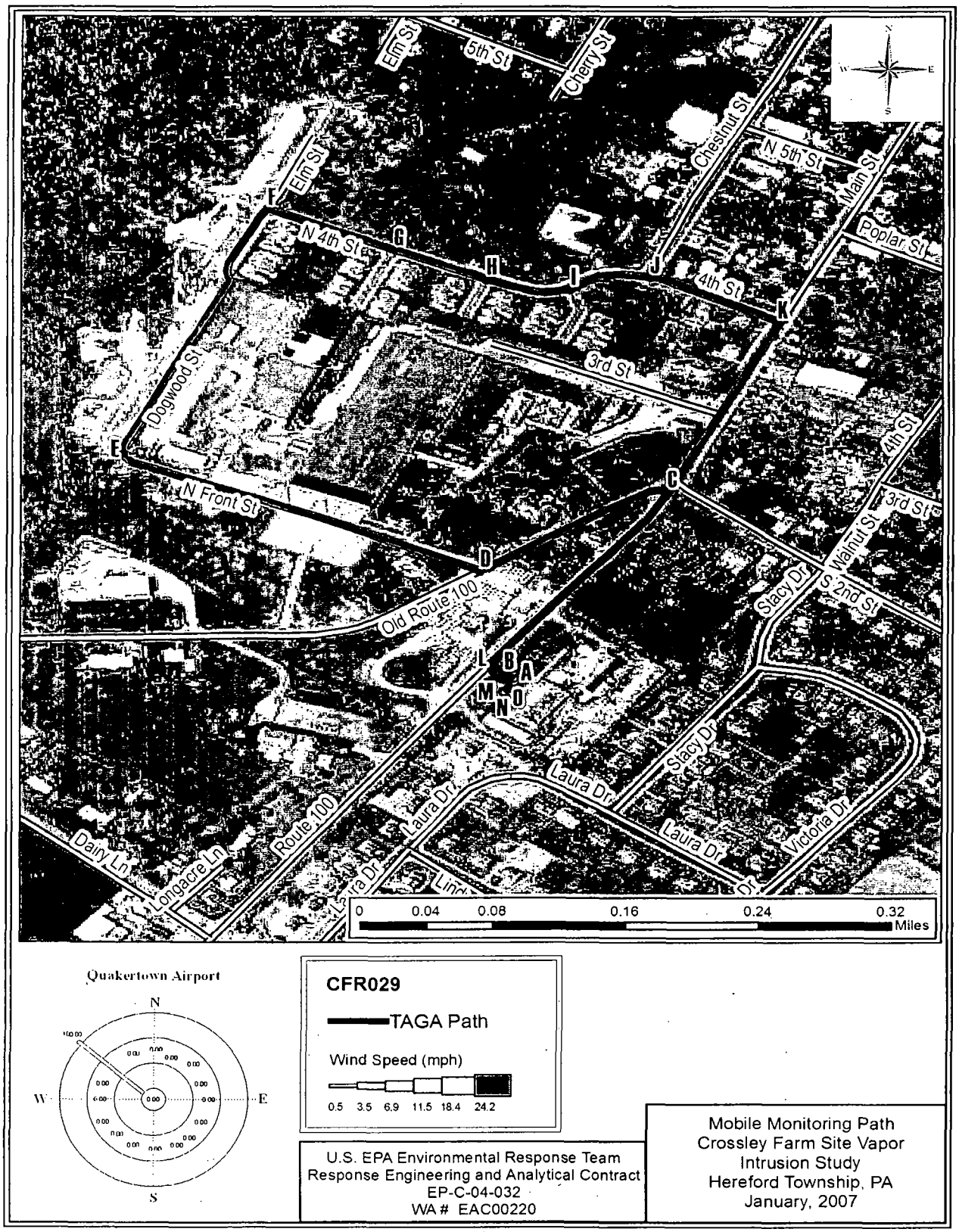


Figure 5a Bally Site Mobile Monitoring Survey Route, CFR029

Figure 5b

TAGA File Event Summary File: CFR029 Acquired on 24 January 2007 at 14:35:32 Title: Bally Site Mobile Monitoring Survey			
Flag	Time	Sequence	Description
A	0.3	26	Start of mobile monitoring at Fronheiser Pools
B	2.3	217	Turning right onto Route 100
C	2.8	263	Turning left onto Old Route 100
D	3.3	317	Turning right onto North Front Street
E	4.9	470	Turning right onto Dogwood Street
F	6.4	612	Turning right onto North 4th Street
G	6.9	657	Traveling along North 4th Street
H	7.3	693	Traveling along North 4th Street
I	7.6	720	Traveling along North 4th Street
J	7.9	749	Passing Chestnut Street
K	10.3	980	Turning right onto Route 100
L	11.0	1046	Entering the parking lot of Fronheiser Pools
M	11.4	1079	End of monitoring
N	13.0	1239	Start of the 30 mL/min spike
O	14.1	1335	End of the 30 mL/min spike

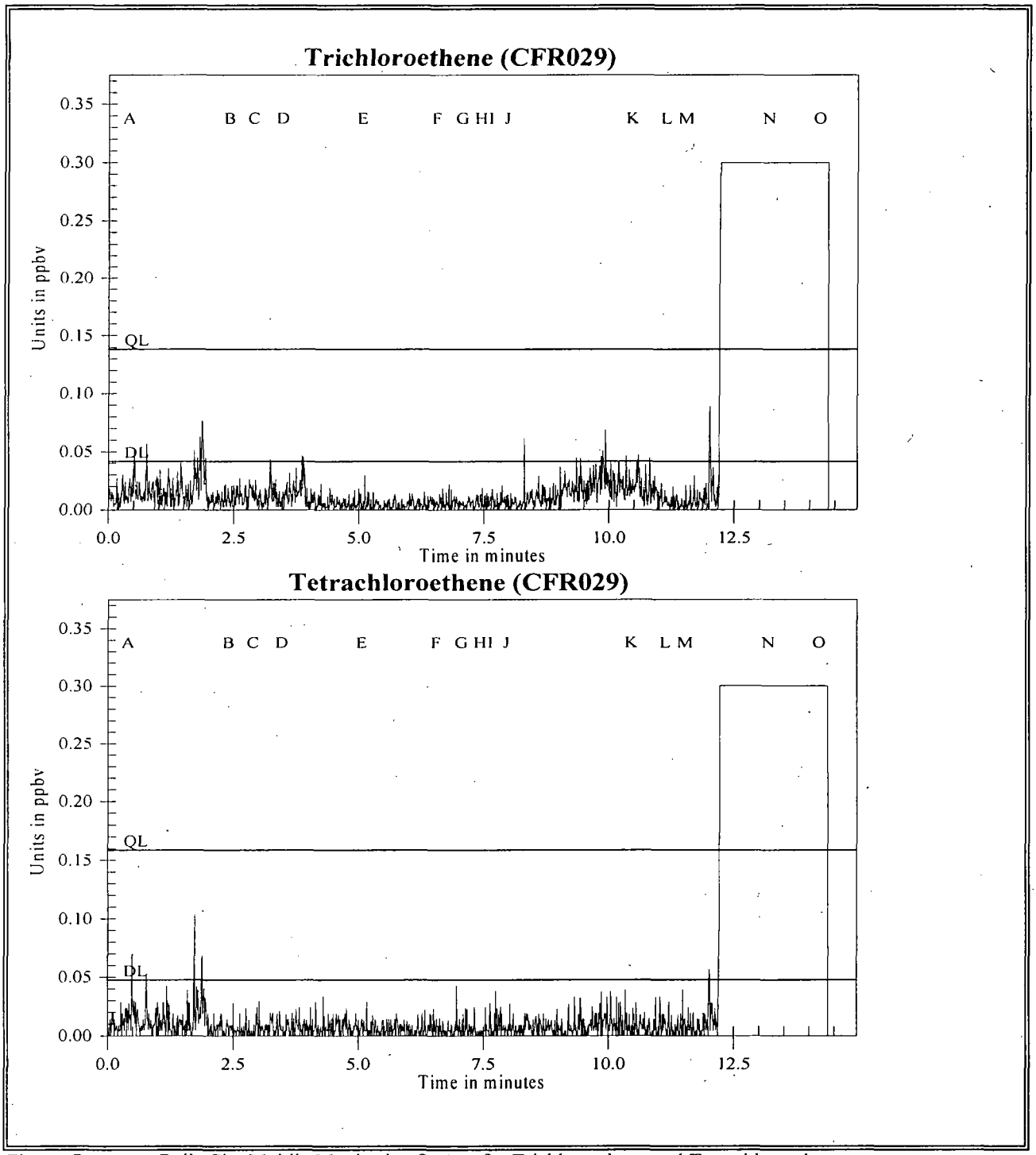


Figure 5c Bally Site Mobile Monitoring Survey for Trichloroethene and Tetrachloroethene

APPENDIX A

Standard Gas Cylinder Certification

Crossley Farm Site Vapor Intrusion Study

Hereford Township, Pennsylvania

February 2007

Spectra Gases, Inc.

3434 Route 22 West, Branchburg, New Jersey 08876 USA

ISO 9001:2000

SHIPPED FROM: 80 INDUSTRIAL DRIVE ALPHA, NJ. 08865

SHIPPED TO: Lockheed Martin
Environmental Services Bldg. 209 Annex
2890 Woodbridge Ave
Edison, NJ 08837

CERTIFICATE OF ANALYSIS

SGI ORDER # :	0099089		
ITEM# :	2	**CYLINDER # :**	CC-56910
CERTIFICATION DATE:	11/09/2006	**CYLINDER PRES:**	1000 psig
P.O.# :	CC-C SHIELDS	**CYLINDER VALVE:**	CGA 350
BLEND TYPE:	CERTIFIED	**PRODUCT EXPIRATION DATE:**	11/09/2007

ANALYTICAL ACCURACY: +/- 2%

COMPONENT	REQUESTED GAS CONC	ANALYSIS
Vinyl Chloride	20.0 ppm	20.1 ppm
Trans-1,2-Dichloroethylene	20.0 ppm	21.0 ppm
Benzene	20.0 ppm	20.1 ppm
Trichloroethylene	20.0 ppm	19.7 ppm
Toluene	20.0 ppm	20.0 ppm
Tetrachloroethylene	20.0 ppm	19.7 ppm
p-Xylene	10.0 ppm	9.69 ppm
m-Xylene	10.0 ppm	9.69 ppm
o-Xylene	10.0 ppm	9.36 ppm
Nitrogen	Balance	Balance

ANALYST [redacted] **DATE:** 11/09/2006

Tel: +1 908-252-9300 Fax: +1 908-252-0811
www.spectragases.com

220-DFA-022807

APPENDIX B

Compiled Meteorological Data

Crossley Farm Site Vapor Intrusion Study

Hereford Township, Pennsylvania

February 2007

QUALITY CONTROLLED LOCAL
CLIMATOLOGICAL DATA
HOURLY OBSERVATIONS TABLE

QUAKERTOWN AIRPORT (64753)

QUAKERTOWN , PA

(01/24/2007)

Elevation: 526 ft. above sea level
Latitude: 40.435
Longitude: -75.382
U.S. Department of Commerce

Date	Time	Sky Conditions	Dry Bulb Temp F	Dew Point Temp F	Rel Humd %	Wind Speed (MPH)	Wind Dir deg	Station Pressure inHg	Precip. Total (in)
24-Jan-2007	40	CLR	30	26	64	6	280	29.39	-
24-Jan-2007	140	CLR	30	26	64	3	280	29.38	-
24-Jan-2007	240	CLR	30	26	64	M	M	29.39	-
24-Jan-2007	340	SCT045	28	25	69	0	0	29.39	-
24-Jan-2007	440	SCT049	28	25	69	M	M	29.39	-
24-Jan-2007	540	SCT045 BKN050	30	27	69	M	M	29.4	-
24-Jan-2007	640	CLR	28	26	75	0	0	29.4	-
24-Jan-2007	740	OVC048	30	28	75	M	M	29.41	-
24-Jan-2007	840	OVC050	32	29	69	0	0	29.44	-
24-Jan-2007	940	FEW042 OVC050	34	31	70	7	270	29.44	-
24-Jan-2007	1040	OVC050	36	32	64	8	290	29.46	-
24-Jan-2007	1140	FEW050	36	31	59	3	290	29.41	-
24-Jan-2007	1240	OVC046	36	31	55	5	300	29.4	-
24-Jan-2007	1340	FEW035 BKN046	36	32	64	0	0	29.38	-
24-Jan-2007	1440	SCT038 BKN048	36	31	55	6	310	29.37	-
24-Jan-2007	1540	OVC048	36	31	59	3	330	29.38	-
24-Jan-2007	1640	FEW033 BKN041 OVC050	34	29	59	0	0	29.39	-
24-Jan-2007	1740	CLR	32	29	69	0	0	29.38	-
24-Jan-2007	1840	CLR	28	26	75	0	0	29.38	-
24-Jan-2007	1940	FEW045 BKN055	28	26	75	0	0	29.38	-
24-Jan-2007	2040	OVC055	27	26	85	0	0	29.38	-
24-Jan-2007	2140	BKN055	27	26	85	0	0	29.38	-
24-Jan-2007	2240	OVC065	27	26	85	0	0	29.38	-
24-Jan-2007	2340	BKN050 OVC065	27	26	85	0	0	29.37	-

Temp	=	Temperature	BKN	=	Broken Cloud Cover
F	=	Fahrenheit	FEW	=	Few Clouds
Rel Humd	=	Relative Humidity	CLR	=	Clear
MPH	=	Miles per Hour	OVC	=	Overcast
Deg	=	degrees	SCT	=	Scattered Cloud Cover
InHg	=	Inches of Mercury			
In	=	inches			